US ARMY ENGINEER DISTRICT, SACRAMENTO SPK-15060
CORPS OF ENGINEERS Apr 89
SACRAMENTO, CALIFORNIA

TO: Architect-Engineers and District Personnel:

1. This is Sacramento District Instruction SPK-15060, FIBERGLASS REINFORCED PLASTIC (FRP) FOR CONDENSATE LINES, dated April 1989.

2. The attached revised guide specification supercedes the previous guide, SPK-15A, dated September 1987, and is for use in the preparation of project specifications.

NOTE: A-E's should read all the TECHNICAL NOTES located at the beginning of this guide specification and edit the specification accordingly.

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GENERAL NOTES

1. This guide specification is to be used in the preparation of contract specifications in accordance with the Sacramento District Specification Manual. It will not be made a part of a contract merely by reference; pertinent portions will be copied verbatim into the contract documents.

2. Where numbers, symbols, words, phrases, clauses, or sentences in this specification are enclosed in the following manner: [ ], a choice or modification must be made; delete inapplicable portion(s) carefully. Where blank spaces occur in sentences, insert the appropriate data. Where entire paragraphs are not applicable, they should be deleted completely.

TECHNICAL NOTES

A. The section number will be inserted in the specification heading and prefixed to each page number in project specifications.

B. Paragraph 1: The listed designations for publications are those that were in effect when this guide specification was being prepared. These designations are updated when necessary by District Instruction, and references in project specifications need be no later than in the current District Instruction for this guide specification. To minimize the possibility of error, the letter suffixes, amendments, and dates indicating specific issues should be retained in Paragraph 1 and omitted elsewhere in the project specification.

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FIBERGLASS REINFORCED PLASTIC (FRP) PIPE FOR CONDENSATE LINES

1. SCOPE: Fiberglass reinforced plastic condensate piping, where allowed as an option to steel by SECTION: HEAT DISTRIBUTION SYSTEMS OUTSIDE OF BUILDINGS, shall conform to the requirements of this section. The work consists of furnishing all labor, equipment, and materials, and performing all operations in connection with the excavation, filling, backfilling, and installation of FRP pipe in strict accordance with this section of the specifications, the applicable drawings, and subject to the terms and conditions of the contract.

2. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

2.1 Federal Specifications (Fed. Specs.):

HH-I-558B & Am-3	Insulation Blocks, Boards, Blankets, Felts, Sleeving, (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type).

2.2 Military Specifications (Mil. Specs.):

MIL-I-24172A	Insulation, Plastic, Cellular Polyurethane, Rigid, Preformed and Foamed-in-Place.
MIL-P-28584	Pipe and Pipe Fittings, Glass Fiber Reinforced Plastic, for Condensate Return Lines.

2.3 American Society for Testing and Materials (ASTM) Publications:

C 177-85	Steady State Thermal Transmission Properties by Means of the Guarded Hot Plate.
C 533-85	Calcium Silicate Block and Pipe Thermal Insulation.
D 695-88	Compressive Properties of Rigid Plastics.

D 1599-82 Test Method for Resistance to Plastic Flow of Bituminous Mixtures using Marshall Apparatus

D 2105-85 Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube.

3. GENERAL: The drawings indicate the extent and arrangement of the piping. If any departures from the contract drawings or the provisions of this section of the specification are deemed necessary by the Contractor, details of and reasons therefor shall be submitted as soon as practicable to the Contracting Officer for consideration. No such departures shall be made without prior written approval of the Contracting Officer.

3.1 Standard Products: All FRP pipe materials furnished shall be the products of a single manufacturer. Insulation materials may be the product of a separate manufacturer. If insulation is factory applied, responsibility for proper factory application of the insulation materials to the pipe and water tight FRP cover shall be that of the FRP pipe manufacturer. FRP insulation covers may be factory applied by a firm other than the FRP pipe manufacturer. Refer to Paragraph: INSULATED FRP PIPE.

3.2 Certificate of Tests: As soon as practicable and within 30 days after award of the contract and before any FRP materials are purchased, the Contractor shall submit a certificate stating that the FRP pipe and fittings to be furnished will be manufactured by a firm which regularly produces such materials in accordance with MIL-P-28584. All required pipe sizes indicated shall be factory certified that tests have been satisfactorily performed in compliance with ASTM Tests: D 695, D 1599, D 2105.

4. FRP PIPE AND FITTINGS: All FRP pipe shall be helically wound. Fittings shall be filament wound with continuous glass fibers impregnated with epoxy resin or shall be compression molded. All pipe and fittings shall be new, shall be the standard product of the manufacturer and shall be manufactured in accordance with MIL-P-28584. All pipe and fittings shall be designed for handling a maximum fluid temperature of 300/F.

4.1 Pipe: The helically wound pipe shall have an outside diameter equal to standard weight steel pipe. The inner surface of the pipe shall have a continuous resin-rich surface layer reinforced with "C" type surfacing veil.

4.2 Pipe Joints: The pipe shall have bell and spigot type couplings and shall be factory sanded on one end as specified by the manufacturer for field joint installation. Two lengths of pipe not exceeding a total of 39 feet 6 inches, may be coupled at the factory for delivery to the job site. All factory made joints shall be completely cured prior to movement or shipment of the pipe. Pipe joints having the "quick lock" type coupling shall be field

welded and continuously joined before the joint cement is cured. Joints not having the "quick lock" feature shall be fitted with a clamp which shall hold the joint rigidly in place until the joint cement has completely cured. The clamps shall have a protective material on the inner surface to prevent damage to the plastic pipe or the exterior of the insulation when the clamp is

tightened in place. In each case the pipe joints shall be laid in a continuous string. Pipe joints shall not be coupled in sections longer than two factory made pipe lengths prior to cementing them to the main pipeline. Cementing of two pipe lengths prior to installation into the main pipeline shall be limited to factory application unless specifically authorized in writing by the Contracting Officer. All factory joints shall be permanently identified by a special marking. The pipe manufacturer shall provide a gauge to measure the pipe ends to assure sufficient material on the exterior surface so that after the pipe is turned or sanded for adhesive bonding, the outside diameter will provide a full length snug fit into the fitting. All pipe ends shall be gauged.

4.3 Workmanship:

4.3.1 The pipe manufacturer shall prepare written FRP fabricating instructions for use by the Contractor. These written instructions shall be approved by the Contracting Officer prior to fabrication of any FRP piping.

4.3.2 The Contractor shall be entirely responsible for the quality of workmanship and for the satisfactory installation of the pipe.

4.3.3 The pipe manufacturer shall assist the Contractor by training and instructing selected Contractor personnel in proper installation procedures and techniques. Certification will be required in writing from the manufacturer listing the names of those individuals so qualified. Personnel not certified will not be permitted to work on epoxy welding of the FRP joints. In addition, a qualified factory trained representative (representative need not be an employee of the manufacturer but the manufacturer assumes full responsibility for the specified duties and functions of the representative) shall be present at the job site at all times during the installations and testing to insure compliance with manufacturer's instructions. The manufacturer's representative shall be a person regularly engaged on a continuing basis in rendering such service and shall likewise be certified in writing by the manufacturer to be technically qualified and experienced to supervise the work. He shall also be authorized by the manufacturer to prepare and sign daily written reports. The reports shall cover unsatisfactory conditions, such as rejection of improperly tapered pipe ends, open pipe ends left in the trench overnight, improper curing of joints, and improperly made up joints. The representative shall take prompt action to return to the factory all damaged and defective materials and shall order prompt replacement of such materials. The Contractor shall obtain the written report from the manufacturer's representative and shall present the original report to the Contracting Officer the same day it is prepared. Upon completion of the project and before final acceptance, the Contractor shall deliver to the Contracting Officer a notarized statement signed by the

principal officer of the Contractor's firm stating that the installation is satisfactory and in complete accordance with the plans, specifications, and the manufacturer's approved brochure.

5. CURING OF FIELD WELDED FRP PIPE AND FITTINGS:

5.1 All joints field welded shall be cured with either a "Wat Low" self regulation temperature controlled electrical heating blanket for 25 to 30 minutes or by other approved heat application method regardless of ambient temperature. The jointed sections shall not be moved either during heating nor until the joint has cooled to 75/F. or to ambient temperature, whichever is lower.

6. INSULATED FRP PIPE: All FRP pipe used for condensate service outside of buildings shall be insulated when installed above ground [and when buried]. Insulation thickness shall be in accordance with Table I.

TABLE I. PIPE INSULATION THICKNESS

Minimum thickness of insulation, inches
in relation to nominal pipe diameter
and dry thermal conductivity:

	Nominal Pipe Diameter, Inches									
k1	1/2-2	2 1/2	3	3 1/2	4	5	6	8	10	12
.0-.35	1.0	1.5	1.5	1.5	1.5	1.5	2.0	2.0	2.0	2.5
.40	1.5	2.0	2.0	2.0	2.0	2.0	2.5	2.5	2.5	3.0
.45	1.5	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.5
.50	2.0	2.5	2.5	2.5	2.5	2.5	3.5	3.5	3.5	4.0
.55	2.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.5
.60	2.5	3.5	3.5	3.5	3.5	3.5	4.5	4.5	4.5	5.0
.65	2.5	4.0	4.0	4.0	4.0	4.0	5.0	5.0	5.0	5.5
.70	3.0	4.5	4.5	4.5	4.5	4.5	5.5	5.5	5.5	6.0

For intermediate k factor use the k factor nearest (e.g., .374 - use .35; .375 - use .40).

k1Dry k, thermal conductivity, B.t.u. per hour per square foot per degree F. temperature difference for a thickness of 1 inch, at a mean temperature of 200/F. Thermal conductivity shall be determined by the ASTM Standard C 177 method. The minimum acceptable k value for calcium silicate and asbestos insulation will be 0.40 for use with this table.

6.1 Insulation of aboveground piping shall be [calcium silicate conforming to ASTM C 533] [cellular polyurethane conforming to Military Specification MIL-I-24172, Type II, Class 2 with minimum density of 2.5 lbs. per cu. ft.;]

[or] [molded fiberous glass insulation suitable for temperature of 450/F, and not less than 7 1/4 pounds per cubic foot.] Molded fiberous glass conforming to Federal Specification HH-I-558, Form D, Type III, except that the insulation shall be suitable for 300/F, shall be used for installations where the bottom of the pipe insulation is 8 feet or more above grade and not subject to damage.

6.2 Insulation for underground piping shall be calcium silicate conforming to ASTM C 533, Type II, Class A (laminated construction shall not be used) or cellular polyurethane conforming to Military Specification MIL-I-24l72, Type II, Class 2 having a minimum density of 2.5 lbs. per cubic foot.

6.3 Covering of Insulation for Piping and Fittings Installed Underground: Insulation shall be waterproofed and covered with an aluminum jacket either in the factory or at the site as specified below.

6.3.1 Field Applied Waterproofing: The insulation shall be provided with a protective covering of one layer of impregnated roof felt and an aluminum jacket. The felt shall be applied with longitudinal and circumferential seams lapped not less than 4 inches, and secured with stainless steel wire (not less than 0.054 inch in nominal diameter) loops. Wire loops shall be individually fastened and spaced not more than 6 inches apart. Aluminum- jacket material shall be of the best grade suitable for the service. Aluminum jackets shall be not less than 0.016 inch thick and shall be secured with aluminum or stainless-steel bands not less than 3/8 inch wide and not more than 8 inches apart. Jacket sections shall have a 1-inch hem turned along one longitudinal edge and shall be applied with the hemmed edge over the unhemmed edge. The longitudinal and circumferential seams shall be lapped not less than 2 inches. Jackets on horizontal lines shall be so installed that the longitudinal seams are on the bottom side of the pipe with the seam of each jacket slightly offset from the seam of the adjacent jackets. The seams of jackets installed on vertical lines shall be placed on the off-weather side of the pipe and shall be slightly offset as on horizontal lines. The jackets on vertical lines and lines pitched from the horizontal shall be installed from low point to high point so that the lower circumferential edge of each jacket overlaps the jacket below it. Special fitting jackets conforming to the above, with the exception of longitudinal lapping dimensions and location of seams, may be used for fittings, valves, and flanges. Jackets for fittings, valves, and flanges shall be properly overlapped and secured.

6.4 Covering of Insulation for Piping and Fittings Installed Underground: The insulation cover shall be bonded to the FRP pipe insulation and to the ends of each separate FRP pipe section in such a manner to assure a seal will be formed to prevent any leakage into the insulated area between the inner FRP pipe and the conduit. The insulation cover (conduit) for FRP pipe installed underground shall be factory applied and be helically wound or filament tension wound or stressed fiberglass reinforced polyester or epoxy and shall have a minimum wall thickness of 0.060 mils. The insulation materials and cover (conduit) need not be the same products of or applied by the same manufacturer supplying the specified FRP pipe provided that the FRP pipe manufacturer warrantees and furnishes the FRP pipe, insulation and cover (conduit) as an

integral unit meeting the specified requirements and pre-qualification tests listed below. Separate warantees for the FRP pipe or insulation or insulation cover (conduit) by separate manufacturers or suppliers are not acceptable.

6.4.1 The insulation cover shall be bonded to each end of the pipe, with a waterproof seal, at a distance from the end of the pipe not more than the normal joint overlap plus one inch.

6.4.2 The insulation cover/waterproof seal shall not fail and shall remain waterproof after completion of the following tests. These tests shall be conducted in the presence of a Government representative, or, when specifically authorized by the Contracting Officer on the basis of and substantiated by certified independent laboratory test results furnished by the Contractor.

6.4.2.1 A standard length of the manufacturer's insulated pipe, with unrestrained ends, shall be placed in a water bath at 40/F. plus or minus 5/F.

6.4.2.2 Water at a temperature of 40/F. plus or minus 5/F. and steam at 30 pounds per square inch absolute pressure plus or minus 2 1/2 psi shall be alternately passed through the pipe for 100 cycles consisting of 2 minutes with 40/F. water and 3 minutes with 30 pounds per square inch absolute pressure steam per cycle.

6.4.3 The insulation cover shall not be visibly deformed by the loaded hanger at the completion of the following test:

6.4.3.1 A length of the manufacturer's insulated pipe shall be placed on supports so that a clear span equal to six nominal pipe diameters is obtained. A free-hanging standard pipe hanger shall be positioned on the insulated pipe, in the inverted position, at the center of the span.

6.4.3.2 Weights, as calculated with the formula of subparagraph which follows, shall be suspended for a period of 24 hours from the inverted hanger.

6.4.3.3 Load weights in pounds = 1.2 x (Maximum hanger span in feet as recommended by manufacturer x total weight per foot of insulated pipe when filled with water).

6.5 Fittings: Insulation of pipe fittings is not required.

6.6 Less Than Standard Lengths: Lengths of insulated pipe less than the manufacturer's standard, as required by field installation, shall be obtained after cutting the pipe to the desired length. The FRP pipe manufacturer shall furnish the Contractor with written details and drawings indicating and depicting the procedures to be adhered to when field joints are made with insulated FRP pipe. The field made joints shall be equal in all respects to the bonded factory joints specified above.

7. UNDERGROUND INSTALLATION: Underground installation shall be accomplished as follows:

7.1 Pipe buried under roadways shall be laid to a minimum ditch depth of 36 inches.

7.2 All pipe buried under aircraft pavements shall be buried to a minimum depth of 6 feet.

7.3 Backfill shall not include large or sharp edge rocks of any size in direct contact with the pipe wall.

7.4 Compacting shall be done so as to avoid damage to the pipe wall.

7.5 Where heavy traffic loads are involved, use Schedule 40 steel pipe sleeve.

7.6 Pipe shall not be bent to follow abrupt changes in the contour of the ditch or to change pipe direction.

7.7 Concrete thrust blocks (not less than 3 cubic feet) shall be installed at all elbows or when the piping changes direction.

7.8 Pipe buried in trenches which are deep enough to permit ground water to inundate the pipe shall be covered with insulation of a type specified in Paragraph: INSULATED FRP PIPE.

8. METAL TO FRP CONNECTIONS: Metal to FRP connections shall be made as follows:

8.1 Flanged Connections:

8.1.1 Both the metal and FRP flanges shall be flat face type. A full face Buna N gasket with a shore hardness of 50-60 shall be used between the metal to FRP flange connection.

8.1.2 Noncorrosive type metal bolt head back-up rings shall be used under the bolt heads on the FRP flanges. When companion FRP flanges are used, large flat washers shall also be used under all nuts. Bolts shall be made of a noncorrosive metal and shall be torqued to not more than 100 foot pounds. Flanges shall not be buried.

8.2 Screwed or Welded Metal to FRP Connections: Aluminum, stainless steel or carbon steel metal adaptors with threaded or welding ends and FRP connections are available on special order from FRP manufacturers and shall be made up at the FRP factory.

9. FIELD TESTS:

9.1 Pneumatic Tests: Pneumatic tests shall not be used for testing FRP

condensate piping systems.

9.2 Hydrostatic Tests: Water shall be used to hydrostatically test FRP condensate piping systems. All free air in the FRP pipe shall be removed before any pressure is applied. A globe valve shall be installed on the

opposite end of the FRP pipe from which the water enters the pipe. The globe valve shall remain open until air in the pipe is displaced with fluid and test liquid, free of air bubbles, flows from the globe valve. The valve shall then be closed and hydrostatic pressure shall be applied at 1 1/2 times the normal working pressure of the piping system. (If the normal working pressure is 75 psi and the specified working pressure is 150 psi, the test pressure shall be 1.5 x 75 psi or 112.5 psi, not 1.5 x 150 psi or 225 psi.)

10. MANHOLES: FRP condensate piping shall be layed in such a manner as to bypass manholes unless the drawings indicate otherwise. When FRP pipe extends through a concrete wall, it shall be fitted into a metal pipe sleeve, a minimum of two inches larger in diameter than the FRP pipe size. The opening between the metal pipe sleeve and the FRP pipe shall be caulked with a waterproof compound which will dry to a firm but pliable mass.

11. PIPE HANGERS: Spacing of pipe hangers varies with the diameter and size of the FRP pipe. Hanger spacing as recommended by the FRP pipe manufacturer shall be used unless otherwise indicated on the drawings.

12. CONSTRUCTION QUALITY CONTROL: Attention is directed to SECTION: CONSTRUCTION QUALITY CONTROL which requires the Contractor to perform quality control inspection, testing, and reporting.

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- REMINDER -

Located at the front of these specifications are the Contract Clauses, Special Clauses and Division I GENERAL REQUIREMENTS of the Technical Specifications, which apply to every aspect of this contract including the work in this section whether performed by Prime Contractor, subcontractor, or supplier.